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IS 11710-2 (2005): Selection and design of diamond core drills - Code of practice, Part 2: Top Drive Hydraulic [MED 21: Diamond Core and Waterwell Drilling]

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भाग 2 शीर्ष द्रव चालित

(पहला पुनरीक्षण)

Indian Standard

SELECTION AND DESIGN OF DIAMOND CORE DRILLS — CODE OF PRACTICE

PART 2 TOP DRIVE HYDRAULIC

(First Revision)

ICS 73.100.30

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

September 2005

Price Group 3

Diamond Core and Water Well Drilling Sectional Committee, ME 21

FOREWORD

This Indian Standard (Part 2) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Diamond Core and Water Well Drilling Sectional Committee had been approved by the Mechanical Engineering Division Council.

The criterion laid down in this standard generally used for exploration, mining, drifting, foundation testing, grout drilling and soil/strata investigation may serve as guideline for use by the manufacturers and the users of diamond core drills.

This standard was first published in 1986 for mechanical drive only. With more and more technological advances made in the field of hydraulics and automation top hydraulic drills are being used world over for exploration of minerals as well as geo-technical investigations. Thus in this revision, this standard has been brought out into two parts. The other part in the series is:

Part 1 Mechanical drive (*first revision*)

Indian Standard

SELECTION AND DESIGN OF DIAMOND CORE DRILLS — CODE OF PRACTICE

PART 2 TOP DRIVE HYDRAULIC

(First Revision)

1 SCOPE

This standard (Part 2) covers selection and design criterion for diamond core drills generally used for:

a) Exploration of all minerals including coal;

b) Mining and other allied drilling jobs including drifting and tunneling; and

c) Investigations connected with foundation testing, grout drilling soil and strata investigations.

2 REFERENCES

The following standards contain provisions, which through reference in this text constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
2266 : 2002	Steel wire ropes for general engineering purposes — Specification (*fourth revision*)
10208 : 1982	Diamond core drilling equipment — Specification

3 TERMINOLOGY

3.1 For the purpose of this standard, the following definitions shall apply.

3.2 Maximum Hook Load

3.2.1 Maximum hook load is defined as:

a) Weight of drill string at maximum drill capacity (for the maximum depth attainable by the drilling machine) when suspended in the air. The weight of conventional (W) and wire line (Q) series rods is given in Table 1.

b) Load, which could be on account of casing string when running casing in the hole.

c) Load during fishing jobs caused by stuck up drilling string.

3.2.2 For defining the capacity of the drill, the weight of drill string shall be considered as defined in **3.2.1**(a) and other conditions as defined in **3.2.1**(b) and **3.2.1**(c) are taken care of by a suitable factor of safety.

Table 1 Weight of Drill Rods

(*Clause* 3.2.1)

Sl No.	Size Code[1]	Weight of 3 m Long Drill Rod with Coupling kg
(1)	(2)	(3)
i)	HW	38.8
ii)	NW	24.5
iii)	BW	19.2
iv)	AW	15.5
v)	HQ	34.9
vi)	NQ	23.6
vii)	BQ	18.2
viii)	AQ	14.1

[1] For size code, IS 10208 may be referred.

3.2.3 Weights indicated for 'Q' designated series rods are typical. The weights of other 'Q' designated series may be as agreed to between the supplier and the purchaser.

4 SELECTION CRITERION

4.1 The selection of a top drive hydraulic drill depends mainly upon the depth to be drilled and the core diameter required at the final depth. Other selection parameters such as type of prime mover, mounting, transmission, feed arrangement, rotation head, rod holder and optional assemblies like wire line hoist, type of control, recording mechanism, mast depend upon individual requirement which are detailed in relevant clauses of this standard.

4.2 Construction of drill, however, depends upon following location of use and type of operating system:

a) Surface, and

b) Underground.

The variant in operating system shall be applicable to both surface as well as underground drills.

5 SELECTION AND DESIGN OF SURFACE DRILL

5.1 Capacity of Drills

5.1.1 Capacity of the drill is usually defined by maximum hook load, which can be safely handled by the hoisting system of the drill as defined in **3.1.2**. The standard capacity ranges are given in Table 2.

5.1.2 The capacity of the mast shall be twice the maximum weight capacity of the drill rods. The depth capacity of the drill in other rod sizes will depend on practical field conditions.

5.1.3 For depth ranges other than those mentioned above, the capacity would be decided by mutual agreement between the purchaser and the manufacturer.

5.1.4 Capacity of the drill should also be considered for selection of suitable circulating fluid pump for which separate Indian Standard is available.

5.1.5 Although, drilling is the main function of a core drill, its capacity is generally specified by the weight of the drill string it is able to hoist. This is so because the power required for hoisting operation is higher than that required during actual drilling operation. Further, maximum stresses are developed in components of the transmission mechanism during hoisting and hence the hoisting operation is more critical for design consideration.

5.2 Power Requirement of the Drill

5.2.1 The power required for the drill shall be provided by an engine of adequate capacity and speed. The power required for a given capacity shall be calculated by the following formula:

$$P = \frac{K \times H_L \times V}{\eta \times 4\,500} \times 0.745$$

where

P = power required, in kW;

K = 1.65, a constant for fishing and running in casing load and also for pressure leakages, friction, etc, in the hydraulic system;

H_L = maximum hook load, in kg;

V = minimum hoisting speed, in m/min, say 40 m/min; and

η = efficiency of mechanism, 85 percent.

5.2.2 For drilling operation in plain terrain, most of the drills are powered by diesel engines. In case of operations in high altitude areas, a suitable factor is to be considered to take care of deration. Petrol engines may also be used in such areas as well as in some other cases where lightweight of the engine is preferred due to transport considerations. Electric motor as prime mover is feasible only in the places where surface drilling is to be carried out and electric power is available. Pneumatically operated drills are used under limited special applications where high manoeuverability is required.

5.3 Mounting

5.3.1 Normally the types of mounting as given in **5.3.1**, **5.3.2** and **5.3.3** are used for surface drill.

5.3.2 *Truck Mounted*

When the terrain for drilling is plain and manoeuverability is easy, it is advantageous to have a truck-mounted drill particularly for medium and deep capacity drills, say over 6 000 kg. The advantage of truck-mounted drill includes quick transportation and erection of drills by using mechanical or hydraulic jacks. The disadvantage in this type of mounting is that the drill can not negotiate steep gradients and undulated terrain.

5.3.3 *Trailer Mounted*

Drills mounted on trailer may be used conveniently in the same terrain as mentioned in **5.3.1**. Normally extra heavy drills of over 15 000 kg capacities are mounted on trailers. In this arrangement a separate towing vehicle is required to tow the trailer.

Table 2 Capacity of the Drills

(*Clause* 5.1.1)

Sl No.	Capacity Designation	Maximum Weight kg	Rod Size	Depth m
(1)	(2)	(3)	(4)	(5)
i)	Low	1 500	NW/NQ	150
ii)	Low	3 000	NW/NQ	300
iii)	Medium	6 000	NW/NQ	600
iv)	Heavy	10 000	NW/NQ	1 000
v)	Heavy	15 000	NW/NQ	1 500

5.3.4 *Skid Mounted*

The skid base shall be rigid, steel structural frame so that the unit is able to negotiate gradients of 1 in 4 under its own power without losing its stability. Skid surface shall be large enough for self propelling of the unit. Construction of the base shall be of adequate strength to bear the weight of the unit and also to overcome the wear and tear due to skidding during transport. The skid surface shall be so designed that it does not cause any obstruction during angle hole drilling. If necessary, detachable front toes may be provided to achieve this aim.

5.4 Transmission

The transmission will be without gear box (for infinite speed variations) or with gear box as per the requirement of the customer. All linear and rotary motion shall be through hydraulic actuators. Hydraulic pumps may be directly connected to the engine shaft.

The range of speed of the spindle in respect of drills of different capacities is provided in Table 3.

Table 3 Capacities *Versus* Speed Ranges

Sl No.	Capacity Range kg	Speed Range rpm
(1)	(2)	(3)
i)	1 500	Up to 2 000
ii)	3 000	Up to 2 000
iii)	6 000	Up to 2 000
iv)	10 000	Up to 2 000
v)	15 000	Up to 2 000

5.5 Hoisting System

The top drive hydraulic drills will have the hoisting drum with hydraulic motor at the top of the mast or at the floor of the machine. Hoisting speed shall vary between 20 m/min to 100 m/min. The hoist drum shall be provided with adequate length of steel rope suitable for single line pull, to lift the rods as per the rated capacity of the drill. The steel wire rope shall be of multi-strand type, left hand ordinary lay, non-rotating type, conforming to IS 2266. The size of the rope to be provided with the drum shall be as specified by the user.

Hoisting may also be done through hollow spindle in case of smaller capacity machines using feed cylinders. It will give additional advantage of breaking up of rod joints at a slower speed.

5.6 Rotation Head

5.6.1 There will be two types of rotation heads, one with hollow spindle and chuck and the other having direct drive from the hydraulic motor-gear box, mounted on the top head. The user may opt for either of the two options or combination of both.

5.6.2 The rotation head shall be driven by hydraulic motors and shall have inbuilt mechanism for holding the rods also operated hydraulically. The direct drive rotation head is mounted on the carriage which slides on the mast and provides a long feed. The hydraulic motors are mounted on the carriage. The drill pipes are screwed to the motors and no chuck is used. The carriage is hinged on one side and can be swung out to facilitate hoisting of drill string. The drive head may be driven directly or through a gearbox having variable speed ranges. The head shall be capable of swivelling in transverse plane through 360° angle range. The rotation head shall be capable of holding rods of *A*, *B*, *N*, *H* and *P* size.

5.6.3 The hydraulic feed/pull cylinder shall be of adequate capacity to provide head traverse to enable rod pull up to 6 m through cylinders and chain or wire rope. The feed length of drills with hydraulic feed shall normally be 2 000 mm and up to 3 000 mm for deeper capacity drills.

5.6.4 The hydraulic pumps shall be of the constant volume or variable volume type of adequate capacity and pressure rating. It shall be capable of running continuously to provide constant hydraulic pressure.

5.7 Mast

The mast/feed frame shall be rigid steel column type which can be lowered horizontally with hydraulic cylinders while the rig is in transportation and can be erected while being used for drilling. The mast shall have arrangements of being tilted for drilling angle holes. The feed frame shall be able to swivel 360° in the transverse plane. The provision will be applicable for diamond core drills only and will not be available on multipurpose combination drills. The mast may be single structure or collapsible telescopic type to provide variable length or stroke/pull.

5.8 Rod Holder

The mechanical drill shall be provided with a suitable foot clamp to hold the string for the different size. The hydraulic drills shall be provided with a rod holder actuated hydraulically.

5.9 Instrumentation and Controls

All controls levers of the drill and the prime mover shall be conveniently grouped at a control panel for ease of operation. Drills shall be provided with following instruments/controls:

a) Bit rpm meter,

b) Bit load or weight on bit meter,

c) Relief valve,

d) Micro feed valve,

e) Emergency stop switch,

f) Depth meter,

g) Rotary torque meter,

h) Drilling fluid pump gauge (optional),

j) Drilling fluid pump flow meter (optional),

k) Penetration rate meter (additional for hydraulic drill), and

m) *Time recorder* — The prime mover shall be provided with a system to record the actual running time.

5.10 Testing of Drill

The testing facilities for testing the capacity of the drill shall be provided by the manufacturer.

5.11 Auxiliary/Optional Components

a) *Wire line hoist* — Built-in type mechanically/hydraulically driven wire line hoist with suitable power take-off incorporating a clutch, brake and an operating lever. In case of hydraulic operated hoists no clutch and brakes are required as hydraulic circuit provides these operations.

b) *Recording system indicators* — Recorder for drilling parameters shall be provided as per requirement of the purchaser.

c) *Lighting system* — Lighting system shall be through the power source of the drill.

d) *Tools* — Adequate tools for operation and maintenance of the drill.

e) *Hydraulic test kit* — Hydraulic test kit comprising of pressure meter, flow meter regulating valve and necessary hoses.

f) *Mud test kit* — Mud testing kit comprising marsh funnel, mud balance, filter press, sand content measuring tube and *p*H meter.

6 UNDERGROUND DRILLS

6.1 Underground drills operate in a different environment and in hazardous conditions as compared with that of surface drills. The headroom available for operation of each drill is also limited. The selection and design of components shall conform to the requirements of statutory Act(s), Rules and Regulations relating to operation of equipment in mines. Therefore, above points need special consideration while designing and selecting drills for underground usage.

6.1.1 Capacity

The capacity ranges, in kilograms, of drills for underground use with AW rods in single line operation as defined in **5.1** shall be as given in Table 4.

Table 4 Capacity of the Drills

Sl No.	Maximum Weight kg	Rod Size	Depth m
(1)	(2)	(3)	(4)
i)	650	AW	100
ii)	1 000	AW	150
iii)	1 500	AW	250

6.2 Mounting

Normally two types of mountings are used for drills for underground use:

a) *Column mounting* — This may be either single or double column. The height of the column will depend on the height of the gallery. In case of low height of the gallery, support jacks and hydraulic bracing devices are used in place of column support.

b) *Skid mounting* — The drill shall be mounted on skid base of rigid steel construction with sufficiently large skid surface for easy movement.

6.3 Prime Mover

6.3.1 Most of the drills are generally powered by compressed air, alternately electrically or hydraulically operated drills may also be used. If permitted by statutory regulations, diesel engine powered drill may also be used. In case of hazardous atmospheres, flameproof electrical motors shall be used as prime mover for drills.

6.3.2 *Power Requirement*

The power required for a given capacity shall be calculated by the following formula:

$$P = \frac{K \times H_L \times V}{\eta \times 4\,500} \times 0.745$$

where

P = power required, in kW;

K = 1.65, a constant for fishing and running in casing load;

H_L = maximum hook load, in kg;

V = minimum hoisting speed, in m/min, say 20 m/min; and

η = efficiency of mechanism, 75 percent in case of mechanical drills and 85 percent in case of hydraulic drills.

6.4 Transmission

The transmission shall be completely through actuators.

6.5 Hoisting System

The drill shall be provided with a hydraulically operated rod puller. Alternatively, a hydraulic or electrically operated winch may be provided. The pulling capacity shall be adequate for the full rated capacity of the drill. As drill has both rotational chuck and rod holder chuck it shall be operated at its rated capacity, without any additional winch.

6.6 Rotation Head

The rotation head shall be of AW/AQ size rod and shall be driven by a hydraulic motor. The feed shall be through feed cylinders. The rotation head and feed system shall be capable of swivelling through an angular range of 180°.

6.7 Controls

All the controls of the drills shall be grouped at a convenient place for ease of operation.

6.8 Up-Hole Drilling

In case of up-hole drilling, the capacity of pump has an important bearing on the capacity of the drill. There shall be provision of holding the drilling string while drilling up-holes.

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